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Effect of Rearing Systems on Fatty Acid Composition and Cholesterol Content of Thai Indigenous Chicken Meat

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***Abstract*—**The experiment was conducted to study the effect of rearing systems on fatty acid composition and cholesterol content of Thai indigenous chicken meat. Three hundred and sixty chicks were allocated to 2 different rearing systems: conventional, housing in an indoor pen (5 birds/m^2); free-range, housing in an indoor pen (5 birds/m^2) with access to a grass paddock (1 bird/m^2) from 8 wk of age until slaughter. All birds were provided with the same diet during the experimental period. At 16 wk of age, 24 birds per group were slaughtered to evaluate the fatty acid composition and cholesterol content of breast and thigh meat. The results showed that the proportion of SFA, MUFA and PUFA in breast and thigh meat were not different among groups (P>0.05). However, the proportion of n-3 fatty acids was higher and the ratio of n-6 to n-3 fatty acids was lower in free-range system than in conventional system (P<0.05). There was no difference between groups in cholesterol content in breast and thigh meat (P>0.05). The data indicated that the free-range system could increase the proportion of n-3 fatty acids, but no effect on cholesterol content in Thai indigenous chicken meat.

***Keywords*—**Cholesterol, fatty acid composition, free-range, Thai indigenous chicken

I. Introduction

THE meat of Thai indigenous chicken has some unique features and seems to have more advantages over imported breed than disadvantages, especially when determined for a niche market serving consumers who prefer chewy and low-fat chicken meat [1]. However most of Thai indigenous chickens are kept in rural areas with minimum feed and management, consequently their productions are very low. In general, the demand of Thai indigenous chicken meat is higher than supply and the price is higher than commercial broiler meat. Increasing production by rearing Thai indigenous chicken in the conventional confined system leads to stress and the problem of feather pecking damage. Our previous study showed that the outdoor access (or free-range) system could reduce the feather pecking damage of Thai indigenous chickens compared to the conventional system [2].

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This indicated that the free-range system is suitable for raising Thai indigenous chickens.

There are a limited number of studies that have compared free-range or conventional Thai indigenous chicken meat quality. Our previous study found that Thai indigenous chickens raised with outdoor access could increase shear value and collagen content in meat and increase yellow color in breast skin [3]. The fatty acid composition of outdoor chicken meat showed a higher fraction of total n-3 fatty acids with respect to conventional broiler chicken meat, caused by grass intake [4]. According to the report of [5], the pasture intake had influence the meat fatty acid profile; the level of n-3 fatty acids was greater in breast meat of broiler in free-range pastured system. It is widely acknowledged that increasing intake of n-3 fatty acids and decreasing intake of cholesterol have been shown to have beneficial effects on human health. Therefore, the outdoor production system seems to be a good alternative method, due to better welfare conditions and good quality of meat. In addition, consumers believe that the meat of free-range chickens is tastier and healthier than that of birds raised in an indoor house only.

The objective of this study was to evaluate the effect of rearing systems of Thai indigenous chickens on fatty acid composition and cholesterol content of breast and thigh meat.

II. Materials and Methods

A. Birds, Diets, and Management

A total of 360, 1-d-old mixed sex Thai indigenous chicks were used in this experiment. Birds were randomly allocated to 2 groups: conventional (control) group, placed in an indoor pen (5 birds/m^2); free-range group, placed in a similar indoor pen (5 birds/m^2), but with access to a grass paddock (1 bird/m^2). In free-range group, birds were kept under the covered area from 6 pm to 6 am and had free access to pasture after 8 wk of age until slaughter. Each group was represented by 6 pens with 30 birds in each. Birds of both groups were fed *ad libitum* the same diet; corn-soybean-based diet without animal ingredient sources, antibiotics and growth promotants during the experimental period. The following diets were used: 1) starter diet for birds 0 to 3 wk of age; 2) grower diet for birds 3 to 6 wk of age; and 3) finisher diet for birds 6 to 16 wk of age. The nutrient composition of experimental diet is shown in Table I.

TABLE I
NUTRIENT COMPOSITION OF THE EXPERIMENTAL DIETS

Nutrients	Starter	Grower	Finisher
Analyzed composition			
Moisture (%)	9.78	9.49	9.87
Crude protein (%)	21.34	19.78	17.33
Fat (%)	12.19	10.17	7.72
Crude fiber (%)	4.88	5.21	3.83
Ash (%)	8.70	6.80	5.10
Calcium (%)	1.02	0.89	0.82
Calculated composition			
Available phosphorus (%)	0.45	0.35	0.30
Metabolizable energy (kcal/kg)	3,100	3,100	3,100

B. Sample Collection and Analytical Determinations

At 16 wk of age, after fasting for 10 h, 24 birds were randomly selected from each group. All birds were weighed individually and killed by manual exsanguination, and thereafter the birds were manually eviscerated. After chilling for 24 h, breast meat (pectoralis major) and thigh meat were collected and stored at -20^{o}C until analyses.

Fatty acid composition was measured on raw breast and thigh meat. The meat lipids were extracted from approximately 15 g of each breast or thigh meat samples using 90 ml of chloroform-methanol (2:1, v/v) according to the method of [6], Fatty acid methyl esters were analyzed by using gas chromatography (Hewlett-Packard 6890 series GC system, USA) with a capillary column (SP 2560, Supelco Inc, Bellefonte, PA, USA, 100 m x 0.25 mm i.d., 0.20 µm film thickness) and a flame ionization detector. Helium was the carrier gas, with a flow rate of 1 ml/min. The temperatures of the injector and the detector were 260^{o}C. The initial column temperature was at 70^{o}C, then increased to 175^{o}C at a rate of 13^{o}C/min, and finally increased to 240^{o}C at a rate of 4^{o}C/min.

Cholesterol content was measured on raw breast and thigh meat. The cholesterol was extracted from approximately 5 g of each breast or thigh meat samples using 20 ml of ethanol-methanol-isopropanol (90:5:5, v/v/v) and 5 ml of 60% KOH according to the method of [7]. The cholesterol was analyzed by using gas chromatography (Hewlett-Packard 6890 series GC system, USA) with a capillary column (HP 19091A-112, 25 m x 0.32 mm x 0.52 µm film thickness) and a flame ionization detector. The temperatures of the injector and the detector were 260 and 300^{o}C, respectively. Separation was carried out isocratically at 300^{o}C with helium gas flow rate of 1 ml/min.

C. Statistical Analyses

Data collected in completely randomized design were subjected to an analysis of variance, and treatment means were compared using Duncan's multiple range test. The level at which differences were considered significant was $P<0.05$. SPSS for windows (Release 10) (SPSS Inc., Chicago, IL) was used for statistical analyses.

III. RESULTS AND DISCUSSION

A. Fatty Acid Composition of Breast and Thigh Meat

Individual fatty acids were quantified and the values for total saturated, monounsaturated, polyunsaturated, n-3 and n-6 fatty acids as shown in Table II.

TABLE II
EFFECT OF REARING SYSTEMS ON FATTY ACID COMPOSITION OF BREAST AND THIGH MEAT OF THAI INDIGENOUS CHICKENS

Fatty acid (%)	Control	Free-range	*P*-value	SE
Breast				
SFA	31.39	31.74	0.77	0.23
MUFA	19.97	20.85	0.73	0.36
PUFA	48.62	47.41	0.49	0.25
n-6	44.99	42.24	0.03	0.25
n-3	3.25	4.46	0.04	0.08
n-6/n-3	21.03	10.43	0.04	0.68
Thigh				
SFA	27.73	26.97	0.52	0.17
MUFA	33.97	33.26	0.52	0.16
PUFA	38.30	39.81	0.39	0.25
n-6	35.96	32.65	0.03	0.16
n-3	1.97	2.48	0.34	0.02
n-6/n-3	20.31	15.44	0.04	0.34

n = 24 per group
SFA = saturated fatty acids, MUFA = monounsaturated fatty acids, PUFA = polyunsaturated fatty acids

There was no significant difference among groups for the proportion of saturated fatty acid (SFA) and monounsaturated fatty acid (MUFA) in breast and thigh meat ($P>0.05$).These observation are in contrast with previous results found that free-range broilers had more SFA and less MUFA compared to conventional birds [4], [8]. Although the proportion of polyunsaturated fatty acid (PUFA) was not changed ($P>0.05$) but the proportion of n-6 fatty acids was decreased in breast and thigh meat of free-range group compared to control group ($P<0.05$). In addition, the proportion of n-3 fatty acids was increased in breast of free-range group compared to control group ($P<0.05$), but there was no difference in thigh meat ($P>0.05$). In agreement with previous results, free-range chickens had more n-3 fatty acids compared to conventional chickens [4], [8].

It is widely known that the composition of dietary fat will affect the composition of fat deposited as carcass fat [9]. The difference in fatty acid composition in meat is likely due to dietary fatty acid intake. Due to both of chicken groups received the same diets, consisting mainly of corn and soybean meal, therefore access to grass may explain the difference between free-range and conventional chickens. In this study, the Ruzi grass was used for a grass paddock in free-range group. The n-3 fatty acids were the major group of fatty acids in Ruzi grass (41% of total fatty acids). According to the report of [5], the pasture intake had influence the meat fatty acid profile; the level of n-3 fatty acids was greater in breast meat of broiler in free-range-pastured system. The n-3 fatty acids are known to have potential in the prevention and treatment of cardiovascular disease, some autoimmune disorders, diabetes, and some types of cancer [10].

In addition, the ratio of n-6 to n-3 fatty acids is an important determinant of health. A lower ratio of n-6 to n-3 fatty acids is more desirable in reducing the risk of many of the diseases [11]. In this study, the ratio of n-6 to n-3 fatty acids was lower in breast and thigh meat of free-range group than that of control group ($P<0.05$).

B. Cholesterol Content of Breast and Thigh Meat

The effect of rearing systems on cholesterol content of breast and thigh meat of 16-wk-old Thai indigenous chickens is shown in Table III.

TABLE III
EFFECT OF REARING SYSTEMS ON CHOLESTEROL CONTENT OF BREAST AND THIGH MEAT OF THAI INDIGENOUS CHICKENS

Cholesterol (mg/100g)	Control	Free-range	*P*-value	SE
Breast	32.93	34.65	0.48	0.35
Thigh	60.14	59.79	0.89	0.36

n = 24 per group

Thai indigenous chickens are slow-growing genotypes, normally, the cholesterol content is lower than other meat-type chickens [1]. In this study, there was no significant difference among groups for the cholesterol content in breast and thigh meat ($P>0.05$). In agreement with previous report, pasture intake had no effect on the total cholesterol concentration in chicken meat [12]. Nevertheless, the influence of pasture intake in cholesterol contents in free-range chicken is unknown. The production systems based on restricted feeding of a commercial diet combined with provision of free-choice dehydrated alfalfa demonstrated that it was possible to produce chicken breast meat with reduced cholesterol content [13]. However, in this study the chicken consumed Ruzi grass with small amounts in the paddock. Therefore, there was no difference of cholesterol content in breast and thigh meat among free-range compared with conventional chickens.

IV. CONCLUSION

The free-range system could increase the proportion of n-3 fatty acids and could reduce the ratio of n-6 to n-3 fatty acids in Thai indigenous chicken meat. However, the free-range system had no effect on cholesterol content in Thai indigenous chicken meat.

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